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 METEOROLOGY, HYDROLOGY

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12. Sponsoring Agency Name and Address  Mr. George Ensor ERTS Technical Offices Code 430 Goddard Space Flight Center Greenbelt, Maryland 20771	13. Key Words (Selected by Principal Investigator)  - Diazochrome Technique - Mapping Programme - Computer Compatible Tapes (CCT)	
14. Supplementary Notes		
15. Abstract  Color enhancement techniques such as diazochrome and false color composite image reconstruction as well as system corrected MSS computer compatible tapes have been utilized for assessment of ERTS imagery potential. Three computer programmes have been developed for preliminary analysis of the System Corrected (SYCI) ERTS-1 computer compatible tape data. The ERTS-1 multispectral imagery analysis has revealed a wealth of information and details, most of them impossible to detect through classical survey approach, in the areas of physiography, vegetational cover, inundation pattern, salt intrusion and sedimentation. A systematic mapping programme has been drawn up.		

## OBJECTIVES

One principal purpose of the Mekong Committee's participation in the Earth Resources Technology Satellite (ERTS) programme is to assess the extent to which ERTS data can be used to compile timely and accurate agricultural statistics for the whole 600,000 square kilometre area of the lower Mekong basin. However, other purposes such as mapping of gross forest types, mapping of surface water and wetlands, sediment patterns and other aspects of hydrology, etc., are being pursuing. These objectives are parts of the continuing work programme of data collection, recommended in the Mekong Indicative Basin Plan, with a view to continuously review and update the goals and components of the various development programmes of this Plan.

This report summarizes our overall assessment of the satellite imagery potential, the techniques used and the plans drawn up for a systematic programme of utilization of the ERTS-1 imagery available.

## TECHNIQUES OF IMAGERY ASSESSMENT

Our research effort was based on techniques of color composite imagery for contrast enhancement and on computer compatible tape analysis.

(i) False color composite imagery has been made by using both bulk MSS negative and positive multispectral black and white transparencies. As already reported in our second Type I to NASA, in April 1973, very satisfactory results were obtained with simultaneous projection of Bands 5 and 7 transparencies only, with regard to color enhancement of forest cover, land use and hydro-geomorphologic features.

The I<sup>2</sup>S Mini-Addcol Additive Color Viewer capable of superimposing up to four 70 mm ERTS-1 individual spectral transparencies registration on a rear projection screen at a fixed magnification was utilized to display 9.5 by 9.5 inch composite image in natural or in false color.

(ii) Use of diazochrome color proofing film has been made, which provided an alternate color composite positive transparency reconstruction from black and white bulk 9.5 by 9.5 inch multispectral positive transparencies.

This color enhancement diazochrome technique is rapid and relatively inexpensive. Better detail and more faithful reproduction from the original imagery are obtained, since it is a contact process, not a projection process.

Furthermore, as most of the 70 mm bulk transparencies available are rather dense, projection process for color composite reconstruction is not always satisfactory; then contact process of the diazochrome technique prove more flexible and practical.

(iii) System corrected MSS computer compatible tapes (SYCI MSS CCT)

From three computer programmes developed, computer compatible tapes relative to a ground scene covered at two different dates (26 October 1972 and 24 January 1973) have been analysed. Computer classification print-out map of hydrologic and vegetational features was made for selected areas in the Vientiane region, Laos. Further study is being planned for other selected areas of the basin where ground truth observations are available.

(iv) Simple photo-interpretation approach, using mosaics of Bands 5 and 7 black and white images at a scale of 1 to 1,000,000, was found of great potentiality. This approach can be used separately or in conjunction with the above techniques.

#### ACCOMPLISHMENTS

The use of ERTS imagery for water resources planning in the lower Mekong basin has been identified which relates more specifically with three major issues :

- Complementing data on forest cover of watershed and geological features at various project sites, inaccessible in the past because of insecurity
- Refining ground survey data in land forms, soils of existing and planned irrigation perimeters
- Providing new information on mechanism of flooding and drainage, sedimentation, salt intrusion and fisheries in the Mekong delta areas.

A paper, entitled "Applications of multispectral imagery to water resources development planning in the lower Mekong basin (Khmer Republic, Laos, Thailand and the Republic of Viet-Nam)" was prepared by the Secretariat and presented at the Symposium on the results of ERTS-1 programme, sponsored by the Goddard Space Flight Center from 7 May to 11 May 1973 in Washington D.C. Significant results of our work and their relationship to practical applications was described in detail in this paper.

Diazochrome color positive transparencies of the whole lower Mekong basin made with ERTS-1 Bands 4, 5 and 7 transparencies for both wet and dry seasons provides for the first time an overall analysis of agricultural patterns, with great detail. Color enhancement techniques allow an easier identification and delineation work of salt intrusion and sedimentation areas in the Mekong delta.

Significant progress have been made with regard to our study of the potential use of ERTS-1 bulk digital data in the form of computer compatible tapes. Three computer programmes have been developed which include a histogramme programme, a pattern recognition programme and a positioning programme. Details on these programmes are given in Annex I. Samples of output data are shown in Annexes II, III, IV and V.

FUTURE

## FUTURE ACTIVITIES

Our programme of applications of ERTS-1 data output, in fact, has just started, since most of our past activities mainly aimed at testing the usefulness of the imagery and at identifying the most suitable approaches for the fullest use of the ERTS imagery.

A systematic programme of ERTS-1 imagery utilization has been drawn up to be started in the near future. Under this programme, three kinds of thematic maps will be established: maps of forest cover and general land use, maps of soils as desired from the physiographic configuration shown on ERTS imagery, and hydro-geomorphologic maps showing flood and drainage pattern of the low-land areas and land forms.

In addition, research will start on crop identification in the selected test areas for which ground truth was collected since the beginning of the ERTS programme.

In this connexion, discussions have been held with a view to establishing a collaboration with specialists of the Centre National d'Etudes Spatiales (CNES) of France, and with various potential ERTS-1 product users in the four riparian countries of the Mekong Committee.

Two riparian engineers will be attending a one-month summer school on remote sensing of Earth Resources at Tarbes, France, from 20 August to 20 September 1973. A programmer-analyst, member of the Mekong Secretariat ERTS-1 Task Force will be visiting the Purdue University in order to have an insight on the latest research at IARS, on agricultural applications of ERTS imagery.

## CONCLUSIONS

Our research effort has convinced us of the great potential of the ERTS products, with regard to their economic use to the planning work of the Mekong Committee. The experience gained by us with this first experimental satellite programme, as well as the "human and technical" infrastructure we have established within the four countries of the Mekong Committee in relation with ERTS-1 programme, will be a strong asset in our future participation with the ERTS-B programme.

ANNEX I

The following programmes have been developed for our preliminary analysis of ERTS imagery :

1. Histogramme Programme

This programme plots the radiance histogram of a selected area on printer and, at an option, prints out radiance values of the four spectral bands. Another feature is added to the program to obtain the histogram only for some categories in an area. Input ranges of radiance values in each band may be imposed to obtain the histogramme plots only for those points which radiance values are within the given ranges.

2. Pattern Recognition Programme

This supervised pattern recognition programme classifies the imagery data and prints corresponding selected characters on printer. Ranges of the radiance values in each band of various categories which will be identified are obtained from the histogramme plots.

3. Positioning Programme

This programme when fully developed will provide the ability to locate a point in an image, in an absolute sense, with reference to the geocentric latitude and longitude obtained from a given set of a center point and tick-marks of each frame. Similar image modeling approximations as described in the Data Users Handbook (Appendix F, Table F. 1-4) were employed :

- a) Flat earth
- b) Non-compensation for keystoneing and obliquity resulting from non-nadir pointing.

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ANNEX II

Radiance map of Tha Ngon (820 ha) farm was compared with ground truth.

Table 1: Representative radiance values for various terrains in the Tha Ngon farm, Vientiane, Laos

(Analysis of SYCI MSS CCT - Frame 1185-03052)

Type of terrain	Band 4	Band 5	Band 6	Band 7
Water	20-24	11-14	-	1-9
Forest (Tree over 5 m)	22-24	14-16	-	15-21
Laterite soil (Road-dike)	23-41	23-50	21-37	14-19
Savanna Brush	22-26	13-18	20-30	13-20
Burnt Savanna	20-22	11-15	10-21	4-10
Graded cleared Land	26-42	25-41	11-17	16-20
Graded land (soybean-peanut)	35-46	31-46	36-41	15-23

Classification print-out map of this same farm is shown in

Annex IV.



# THA NGON PROJECT

820 ha

COMPUTER PRINT-OUT  
Approximate Scales

Horizontal 1: 7,700

Vertical 1: 6,300

0 250 500 750 1000 M

0 250 500 750 1000 M



ANALYSIS OF  
ERTS-1 SYCI MSS CCT DATA

Taken 24 Jan. 73  
(Frame ID 1185-03052)

MEKONG COMMITTEE

JULY 73

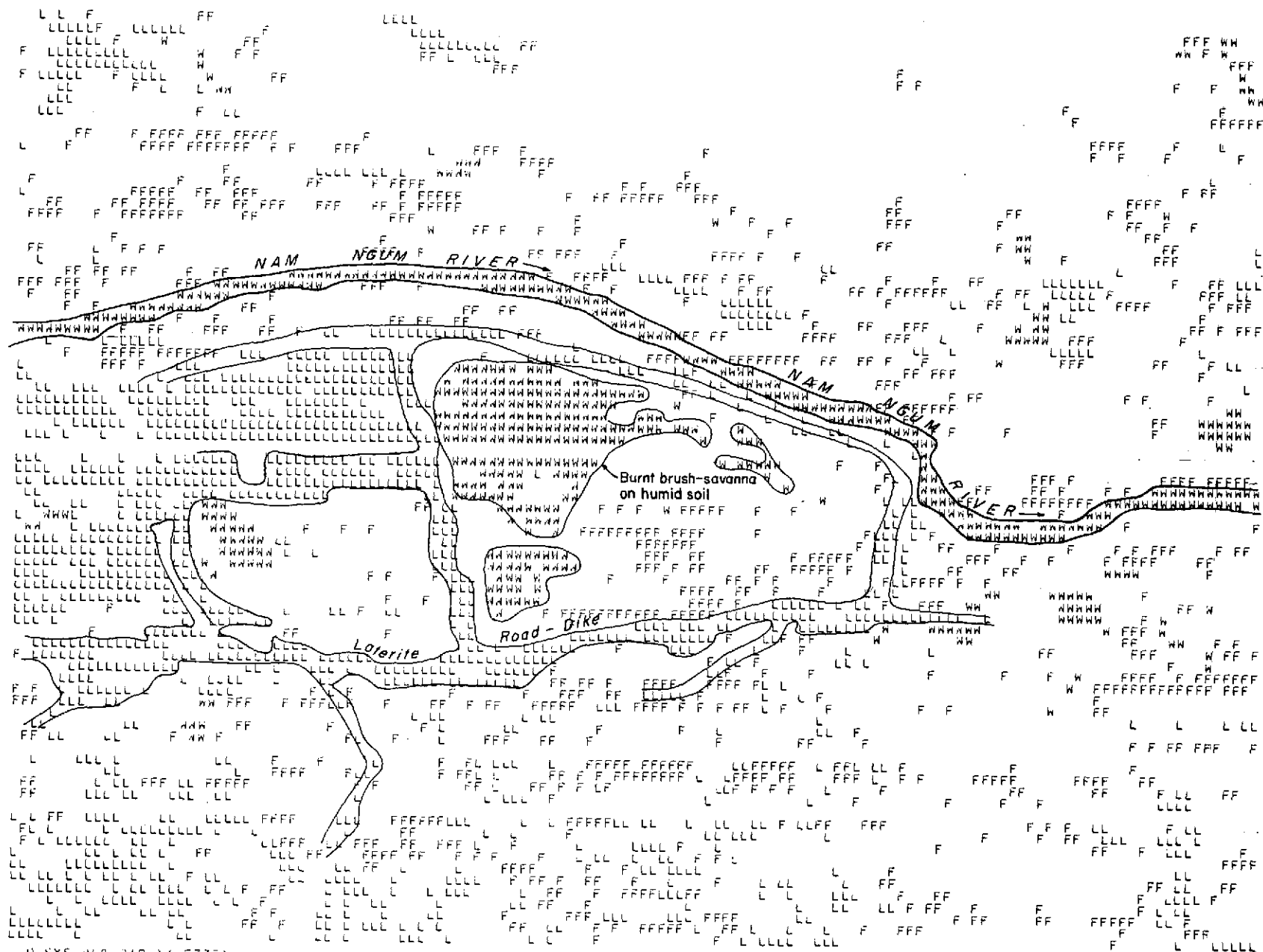
## THA NGON FARM (820 ha)

ERTS-1 image taken 24 Jan. 73

(Frame 1185-03052)

LL = Laterite soil and bare land

FF = Forest and brush

WW = Water and also burnt brush-savanna  
on humid soil



# MEKONG RIVER, NEAR VIENTIANE FLOOD PLAIN, LAOS

